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The Optics of the Sunshine Sphere

By E. G. Bilham, B.Sc., D.I.C.

In the well-known sunshine recorder devised by Sir G. G. Stokes and based on earlier instruments by J. F. Campbell of Islay, R. H. Scott and Sir G. B. Airy, several conditions have to be fulfilled if comparable records are to be obtained from different localities. The need for an uninterrupted exposure and for correct adjustment of the instrument are well-known. Little attention has, however, been paid to the need for very close agreement between individual spheres, with regard to their optical properties, and it is the purpose of this article to indicate briefly the nature of the problem involved.

It will be recalled that the Campbell-Stokes instrument consists of a metal frame or collar, provided with slots into which cards may be inserted for the reception of the image of the sun formed by a glass sphere four inches in diameter. For a discussion of the theory of the instrument, the reader is referred to Sir G. Stokes's paper in the *Quarterly Journal of the Royal Meteorological Society*, Vol. VI., pp. 83-93. It will suffice for our present purpose to point out that exact coincidence between the centre of the sphere and the centre of the spherical surface of which the bowl forms a part is essential. In other words, there is no possibility of allowing for small differences in the focal lengths of individual spheres by varying the position of the sphere relative to the card. The focal length of the sphere must,

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therefore, conform to a predetermined value. Now, in practice absolute exactitude is not obtainable in any form of scientific applicance, and it is customary to permit the manufacturer a certain latitude or "tolerance." We have, therefore, to determine (A) what should be the focal length of the sphere and (B) what degree of divergence from the specified value is permissible.

It is rather curious that in Stokes's original description of his recorder, the focal length of the sphere for which it is intended is nowhere stated in exact terms. In discussing the dimensions, he states that "if the glass spheres be of four inches diameter, and the glass be free from lead, R (*i.e.*, the focal distance for best burning) will be a little under three inches." The perpendicular distance from the centre to each of the supporting surfaces for the cards was, however, fixed at 2·89 inches. The cards are ·02 inch thick, so that the minimum distance between the centre and the solar image on the card is 2·87 inches. The maximum distance is about 2·90 inches. Some of the earliest spheres in use have been found to have a visual focal length of 2·97 inches, and this value was adopted in the Meteorological Office specification which was in force until 1921. It seems clear, therefore, that Stokes was aware of the fact, which we shall subsequently enlarge upon, that the card must not be placed exactly at the visual focus in order to get the best burning.

In 1921 it was decided, in order to secure greater permanence of colour, to make a change in the variety of crown glass used for the manufacture of spheres. This change involved a slight reduction in the focal length, from 2·97 inches to 2·95 inches. Actually, the specified data were the diameter (3·99 to 4·01 inches) the refractive index for sodium light (1·511 to 1·513), and the weight (2·96 to 3·04 lbs.). This specification permitted of variations of focal length from 2·94 to 2·96 inches. It will be seen later that this change was not likely to affect the burn appreciably, and comparisons between spheres made in accordance with the two specifications did, in fact, show no perceptible differences. We shall see that the adopted value is appropriate to the standard bowl of Stokes's specification, and in view of the fact that glass of the prescribed refractive index can be made with satisfactory uniformity nothing would be gained by further change in the specification.

It is of interest, however, to consider the question from the abstract point of view, and it is curious that investigations have been proceeding simultaneously and independently both at South Kensignton and at Potsdam with closely parallel results. The general conclusions may be illustrated by a very simple experiment, during the performance of which the investigator must wear dark spectacles. A sunshine sphere is placed on a suitable support in bright sunshine and a card is slowly

brought upwards towards the sphere on the side remote from the sun. The following phenomena are observed: with the card well outside the focus a diffuse patch of light is observed which becomes brighter and more concentrated as the card approaches the focus. Very little tendency to burn is observed, however, until the card is within a tenth of an inch of the focus. The card then begins to burn more and more freely. When the focus is passed the image takes the form of a sharply defined disc of gradually increasing diameter. The card continues to burn quite readily even when the card is within half an inch of the sphere. It is seen, therefore, that conditions are markedly different, both optically and thermally, on the two sides of the focus. If an ordinary magnifying glass is substituted for the sphere it will be found that burning only occurs close to the visual focus. Clearly therefore, a sunshine sphere cannot be treated as a simple lens.

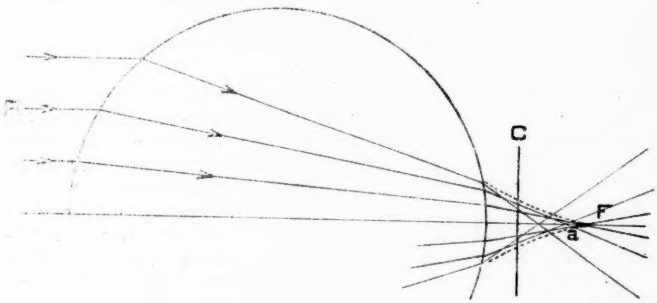


FIG. I.

The reason for this becomes clear if we consider Fig. I. which shows the paths of rays of light incident at varying distances from the axis. The emergent beam consists of a cone of rays enveloped by a caustic surface whose apex represents the focus F for a very narrow pencil of rays along the axis. A ray such as A, not on the axis, comes to a focus at a point *a* between F and the sphere, the distance F*a* increasing with the distance of A from the axis. It will be seen that all rays beyond F are divergent, while between F and the sphere any point on the axis is a focus for some particular zone. The asymmetry noticed in the experiment is thus accounted for. If a card is placed at some such position as C the image is found to consist of a bright ring of light, representing the line of intersection of the plane of the card by the caustic surface, with a central bright spot and an intermediate zone of lower luminosity. If the card is placed in actual contact with the sphere, a bright ring of diameter about 2 cm.

will be seen. If the diameter of the ring is measured and the diameter of the sphere is known, the refractive index, and thence the focal length, can readily be calculated. F. Albrecht,* of Potsdam, has adopted this as a standard method of determining the focal length. The same investigator has recently determined the actual distribution of temperature in the region of the focus and has shown that, in the case of a sphere of refractive index 1·5, the maximum burning power occurs at a point about 6 mm. nearer to the sphere than the visual focus F. The position of this point was found to be dependent to some extent on the nature of the card used in the recorder.

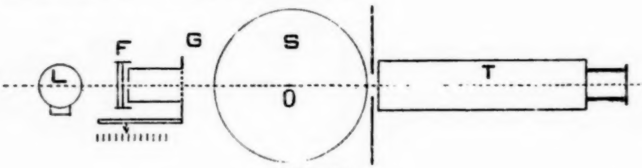


FIG. II.

At first sight it might appear that this result merely arises from the possibility that the rays which are chiefly instrumental in burning the card lie outside the visible spectrum. From the known facts about the distribution of energy in the solar spectrum, however, we should not expect to find the best burning focus in the ultra violet, which is the natural consequence of this suggestion. Albrecht's result is more reasonably interpreted as meaning that the integrated effect of all the rays, converging or diverging, reaches a maximum value at the point found. This experimental result is all that need concern us, since for a given quality of glass it is only necessary to specify the focal length for a given wave length in order to reproduce the standard distribution of energy along the axis, exactly.

From the above considerations it will be clear that it is very important to ensure that the focal length of the sphere is fairly close to the specified value, and it is also clear that too short a focal length is a much more serious fault than an error in the opposite direction. It has been decided to retain 2·94 inches as the minimum for spheres used in the standard Meteorological Office recorder, the values given referring to sodium light confined to an axial pencil about 3/16 inch in diameter.

For the determination of the focal length the method illustrated diagrammatically in Fig. II. is in use at the Meteorological Office, South Kensington. S is the sphere, geometrically supported on a suitable stand, and G a finely engraved graticule

* Met. Zs. Heft. 11, 1925, pp. 443-6.

for focussing purposes. This graticule is mounted on a carriage movable by rack and pinion along the axis, the distance of G from O, the centre of the sphere, being indicated on a scale. A short length of brass tube fixed to the graticule mount cuts out stray light and also supports the filter F which transmits approximately monochromatic light whose wave length is that of the D lines of sodium. The stop which defines the width of the pencil is placed just in front of F. A lamp L with opal bulb provides the illumination. T is a telescope focussed for infinity. It will be seen that if the graticule G is placed at the back focus of S, the graduations will appear sharply focussed on looking through T. To use the apparatus it is only necessary to focus the graticule by means of the rack and pinion and read the scale, which gives the focal length immediately. The focussing is remarkably sharp and the focal length can be determined readily to within ·01 inch.

Before concluding, some mention should be made of the effect of those faint striations which are frequently seen if a sunshine sphere is examined closely. They are due to imperfect optical homogeneity and a badly affected sphere may fail to yield a clear image in any position when tested by the method just described. To test the effect on the burning power of the lens a very clear sphere and a badly striated sphere of the same focal length were carefully compared against a standard at Kew Observatory. The two spheres were used on alternate days in the same bowl and the record obtained was expressed in each case as a percentage of that yielded by the standard recorder. The effect of the striations was found to be unexpectedly small. No perceptible diminution of record, even at times of faint sunshine, was in fact found. On the other hand, a clear sphere of focal length 2·89 inches was found to give a perceptibly weaker burn than one of standard focal length and there was an appreciable loss of record during feeble sunshine.

OFFICIAL PUBLICATIONS

The following publication has recently been issued :—

Advisory Committee on Atmospheric Pollution. Eleventh Annual Report ; for the year ending March 31st, 1925.

THE report is divided into four sections. In the first section, which deals with the deposit of impurity at forty-eight stations, it is shown that the deposit of tar was lower than the average for the previous five years. There was little difference in the deposit of sooty matter but the total impurity was somewhat less than the average in most stations. Section 2 deals with the automatic recorder for suspended impurity, and the effect of

wind in governing the concentration of impurity is also discussed at some length. Section 3 describes dust counter observations made in different countries, while in section 4 the special researches undertaken by the Committee are given.

GEOPHYSICAL MEMOIRS—

No. 28. *The Doldrums of the Atlantic.* By C. S. Durst, B.A. (No. 254*h*).

This publication deals with the meteorology of the interesting region of calms and variable winds, usually found just north of the equator, termed the Doldrums. It is found to vary considerably in position, and the variations are associated with variations in the humidity of the two trade winds which bound it on either side. This leads to a theory to explain the existence of a belt of doldrums.

Discussions at the Meteorological Office

January 18th. *Polareis und atmosphärische Schwankungen.* By W. Wiese (Geog. Ann. Stockholm VI, 1924, pp. 273-299), and *Die Einwirkung der mittleren Lufttemperatur im Frühling in Nord-Island auf die mittlere Lufttemperatur des nachfolgenden Winters in Europa.* By W. Wiese (Met. Zs. 42, 1925, pp. 53-57). *Opener*—Sir Gilbert Walker, C.S.I., F.R.S.

The papers discussed deal first with methods of forecasting the amount of ice in the Barents Sea, especially by means of the position of the trough of low pressure in the Norwegian Sea: it appears also that the ice is very persistent, and the amount in one year is an important element in the forecast for the following year. The main contention of Wiese is that the Barents Sea is an important action centre, and the amount of ice there is related to the general atmospheric circulation, rainfall in equatorial regions, etc. It also provides a useful method of forecasting the rainfall in south-east Russia. The discussion brought out the fact that many of the correlations employed were based on short periods of years, and were not confirmed when the period was extended. An article on the subject by Sir Gilbert Walker will appear in the *Meteorological Magazine* for March.

February 1st, 1926. *Solar radiation and weather or forecasting weather from observations of the sun.* By H. H. Clayton (Smithsonian Misc. Coll. 77, No. 6, pp. 64). *Opener*—Capt. H. F. Jackson, M.S.E.

A review of the above work will be found on p. 237 of the November issue of the *Meteorological Magazine.* An interesting discussion followed the exposition of the paper by Capt. Jackson. Dr. G. C. Simpson said that it was not easy to attach an actual physical meaning to many of the diagrams shewn. His chief

impression of the paper was the entire lack of judgment displayed in drawing deductions from the data. It was now becoming recognised that the day to day fluctuations of the observed values of the solar constant were essentially connected with variations in the transparency of our atmosphere. Sir Napier Shaw said that there had been a great amount of effort expended on the work but he felt it would have been better if the author had merely presented the data and left each reader to draw his own conclusions. Interesting contributions to the discussion were also made by Sir Gilbert Walker and Col. Gold.

The subjects for discussion for the last two meetings of the session will be—

March 1st, 1926. *On radiation and climate.* By Anders Angström (Geog. Ann. Stockholm, VII., 1925, pp. 122-142). *Opener*—Mr. J. Crichton, M.A., B.Sc.

March 15th, 1926. Untersuchungen über die Elemente des Nebels und der Wolken. By H. Köhler (Stockholm, Statens Meteor.-Hydrog. Anstalt. Med. Bd. 2, No. 5). *Opener*—Lieut.-Col. E. Gold, D.S.O., F.R.S.

Royal Meteorological Society

The Annual General Meeting of the Society was held on Wednesday, January 20th, at 49, Cromwell Road, South Kensington, Mr. C. J. P. Cave, M.A., President, being in the Chair. The Report of the Council for 1925 was read and adopted, and the Council for 1926 duly elected, the new President being Sir Gilbert Walker, C.S.I., F.R.S.

The Symons Gold Medal which is awarded for distinguished work done in connection with meteorological science was presented to Lieut.-Col. Ernest Gold, D.S.O., F.R.S.

Mr. C. J. P. Cave delivered a brief address on the work of the Society during the past year and then showed a collection of lantern slides of cloud photographs.

At the invitation of Colonel H. G. Lyons, F.R.S., Director of the Science Museum, fellows of the Royal Meteorological Society visited the new meteorological gallery of the Science Museum on Wednesday, February 3rd, at 5 p.m., to see the meteorological collection.

The collection is now housed in a spacious and well-lighted gallery on the second floor of the new building of the Museum from which the instruments on the roof of the Meteorological Office can be seen, and next to it are the geophysical, astronomical, and mathematical sections of the Museum. Those who remembered the former arrangement of the collection in the

old "Western Galleries," in the building now occupied by the Imperial War Museum, were agreeably surprised to see the enormous increase in accommodation which is afforded by the new gallery; and the effective display of the exhibits in the care of the Museum, many of which had hitherto been kept in store owing to lack of accommodation, was freely commented upon. Many new exhibits were seen, and particular mention should be made of the historical collection of thermometer screens from various countries, which will be of special interest to meteorologists who have followed the attempts to devise a satisfactory screen for the measurement of air temperature. There is also a historical collection of British Weather Maps, and arrangements are being made for the display of a number of fine transparencies of cloud photographs by Mr. G. A. Clarke, of Aberdeen Observatory. The meteorological and geophysical instruments now in use in this country are well represented in the collection.

It is evident that the authorities of the Science Museum have realized the great importance of setting out the historical development of the subject, and this feature is specially to be commended.

Correspondence

To the Editor, *The Meteorological Magazine*

A Blue Moon

On my way to the station this morning, shortly before eight, the sunrise, on very fleecy cirro-cumulus clouds in the south-east and south, gave them a rather unusual tint. The pink had a touch of brown, giving a shade perhaps best described as pale salmon. There seemed to be clear interspaces, but probably these too were tinted. The moon, visible through cloud nearly as much as interspace, instead of taking the usual greenish tint by contrast, was of an exquisite pale blue, deeper on the brighter outer edge. The shade of colour is hard to describe. Among flowers the nearest I can think of are the sea holly and Miss Jekyl's "Love in a Mist." Both of these probably have a slight touch of green. It reminded me too of the blue flashes one gets with an opal. By 8 o'clock the moon was growing white as the sunrise tints disappeared. It was watched for 10 minutes and attracted the attention of others as well as myself. Was the phenomenon widespread?

J. Edmund Clark.

41, Downscourt Road, Purley, Surrey. January 8th, 1926.

Smoking Snow

On Tuesday, December 29th, when motoring across the North Yorkshire moors, I observed a phenomenon which was particu-

larly interesting to me although it is quite possible that many of your readers have observed similar occurrences. The exceptionally heavy falls of snow in Yorkshire both before and during Christmas week have been reported and commented upon in many newspapers, the deep drifts on the moorland roads making traffic quite impossible for a time. A general thaw set in about Boxing Day, December 26th, but on the afternoon of December 29th there were still many deep snowdrifts and banks of piled up snow on the roadsides on the high moors between Pickering and Whitby.

On this particular afternoon a strong, very warm southwesterly wind was blowing and frequent heavy rainstorms occurred. As we passed along all the heaps of snow appeared to be giving off white clouds of "smoke" which blew away to leeward for a short distance and then disappeared as the moisture temporarily condensed by contact with the snow again evaporated. I have read of the "banner cloud" and of Cervin (the Matterhorn) "smoking his pipe" in similar conditions (*vide* Dr. Richard Garnett's *A little book on Water Supply*), but I have never before seen piles of snow smoking like rubbish heaps!

The afternoon of December 29th was unusually warm, the maximum reading on my return to York was 57·8° F., which may be compared with a minimum reading of 21° F. during the night of December 24th-25th, incidentally showing a fairly wide range of temperature over a period of five days.

A. Wentworth Ping.

St. Peter's School, York. January 4th, 1926.

Possible Errors in Annual Rainfall Totals obtained by the Summation of Daily Records

The methods suggested in my communication of April 2nd, 1925,* for obtaining the rainfall of a year free from the inaccuracy resulting from the accumulation of a large number of small errors in the daily records, have now been in use for 12 months with the following result:—The official record has given 181 rain days with an arithmetical total of 24·99 in. Water was, however, found in the gauge on 212 days, on 31 of which the amount was below ·005 in. The total of these traces was ·087 in. On only 31 days did the reading agree exactly with the official record; on 83 days the amount being above, and on 67 days below, by quantities ranging from ·001 to ·004 in. The excesses (including the traces) amounted to ·264 in., and the deficiencies to ·223 in., so that they nearly balanced each other, and the rainfall for the year, when all the readings were made with the highest attainable accuracy came out 25·031 in. (the traces being included) or ·16

* See *Meteorological Magazine*, 60 (1925), 88.

per cent. above, or, if the traces are ignored, 24·944 in., or ·19 per cent. below the official record. The remeasurement in bulk (at the end of each month) of the stored water gave a total of 25·054 in.

As far, therefore, as this test goes, it would appear that recording daily falls to the nearest hundredth of an inch gives a total of quite sufficient accuracy.

I regard the measurement of the stored water as the most accurate method, but I would submit the following considerations. For measuring large volumes the cylinder holding ·50 in. is the very worst form. In my own case I had to fill it 50 times to measure 25 in. of rain. A globiform flask, with a narrow neck, holding 5 or 6 in. of rain would be an ideal form. A 2-litre flask (obtainable from any dealer in chemical apparatus) would hold water equal to 6·216 in. of rain on a 5 in. gauge and 4 fillings would supersede 50 fillings of the ordinary cylinder, with a great gain in accurate reading and much economy of time.

MORTYN J. SALTER.

Bank House, Mickleton, Glos. January 1st, 1926.

NOTES AND QUERIES

Wireless Weather Reports from Greenland

A telegram was received in the Meteorological Office on Friday night, February 5th, from Dr. la Cour, Director of the Danish Meteorological Institute, saying that the wireless station at Julianehaab in Greenland (half-way between Cape Farewell and Cape Desolation, about 100 miles from either) was beginning to transmit meteorological observations from Greenland twice a day, the transmission being made at noon and midnight. The first actual report received was that for midnight on Saturday, February 6th, having been re-transmitted at 7h. 35m. on Sunday morning by the Danish station at Lyngby. As this is a report of historic interest we reproduce it :

"Julianehaab 06 0000 GMT 46081 25361"

(Barometer, 746 mm. falling. Wind, East, Force 1. Weather, Fog. Temperature, −3°C. Past Weather, Cloudy).

So long ago as 1880, the International Meteorological Committee, at its Berne meeting, examined a proposal of Captain Hoffmeyer, to remedy to a certain extent the disadvantages of the situation in which the European Meteorological Service was placed, by the establishment of meteorological stations at the Faeroes, Iceland, Greenland and the Azores, in telegraphic communication with Europe.

It is over 30 years since the first part of the scheme was made possible by the completion of the cable to the Azores (first report from Ponta Delgada, October 20th, 1893). On October 11th, 1906, the reports from the Faeroes and Iceland com-

menced. Now, nearly half a century after Captain Hoffmeyer's proposal, his plan has been completed by the establishment, not of a cable connection with, but of a wireless station in, Greenland* The achievement, so far as Faeroes, Iceland and Greenland are concerned, is due to the efforts of Captain Hoffmeyer and his successors in the Directorship of the Danish Meteorological Institute; so far as the Azores are concerned, it was due to Col. Chaves. All Europe is their debtor.

E.G.

A Course of Training for Observers

It is proposed to hold a fourth general course of training for meteorological observers, at Kew Observatory, Richmond, Surrey, during the week, April 19th to April 24th, 1926, both dates inclusive, provided that a sufficient number of applications are received.

The subjects to be dealt with will include the following:—

- Meteorological instruments and methods of observation.
- Recording of observations and their transmission to the Meteorological Office.
- The Weather Map; charting of observations distributed by wireless telegraph.
- Climatology.

The course is addressed primarily to observers at stations which report regularly to the Meteorological Office. Others will, however, be admitted, at the discretion of the Director, as far as the accommodation permits. Applications for tickets of admission should be made to the Director, Meteorological Office, Air Ministry, Kingsway, London, W.C. 2. There will be no fee for the course, but travelling and other incidental expenses incurred by observers attending the course will in no case be paid by the Meteorological Office.

Climatic Changes in America

It would be a useful exercise in geography to read the four papers included in "Quaternary Climates"† and then to attempt to combine the evidence presented by the different authors and deduce an account of the climatic changes in the western part

* In the autumn of 1922 a temporary wireless station was set up at Mygbugten, on the east coast of Greenland, by a Norwegian hunting expedition equipped for the purpose by the Norwegian Meteorological Service. Weather messages were transmitted twice daily until August, 1923, when the expedition left Mygbugten. (See the *Meteorological Magazine* 58 (1923) 256).

† Carnegie Inst. Wash. Publ. No. 352. July, 1925. Quaternary climates. Geologic history of Lake Lahontan. By J. Claude Jones. On the pleistocene history of the Great Basin. By Ernst Antevs. The Big Tree as a climatic measure. By E. Antevs; and Tree growth and climatic interpretations. By Ellsworth Huntington. pp. v. + 212. (*Illus.*)

of the United States which does not conflict with any of the facts.

The materials are briefly as follows: in southern California and Arizona there grow the "Big Trees" (*Sequoia*), which live to an age of three thousand years or more. A. E. Douglass has shown that the variations of the rate of growth of these trees, indicated by the width of the annual rings, depend very closely on the variations of the rainfall, so that we have a natural record of the rainfall over a period of more than three thousand years. The chief difficulty is that the scale of the record varies. A tree grows more rapidly when it is young than when it is middle-aged, and when it is old its growth becomes irregular. Evidently some standard is required by means of which the ratio of growth can be corrected to a uniform scale. Professor Huntington, in an earlier paper, employed the fluctuations of the level of the Caspian Sea, but since the early levels of this sea are themselves very doubtful, and their connexion with changes in western America is not yet proved, calibration by this method is not satisfactory. By a fortunate chance it happens that in the region where grow the Big Trees there are a number of salt lakes, and in the first paper Professor Jones attempts to determine the age of Lakes Pyramid and Winnemucca from the amount of salt at present contained in those lakes. Four determinations were made, with the following results:—

Rate of accumulation of chlorine from Truckee River	3,880 years.
Rate of accumulation of sodium from Truckee River	2,450 years.
Accumulation of chlorine in last 31 years ..	1,956 years.
Rate of concentration of chlorine by evaporation	2,400 years.

The concordance is not very good, and the way in which the evidence is presented leaves a great deal to be desired, but the figures seem to show that the lakes contained fresh water between 2,000 and 3,000 years ago. A lake may be fresh for one of two reasons, either because it has an outlet so that the water in it is continually being changed or, if it has no outlet, because it has only just been formed and has not had time to become salt. Since Lakes Pyramid and Winnemucca show no signs of having ever overflowed, the second explanation must be the correct one. After the lakes were formed they stood for some time at a level 120 feet above the present, then rose rapidly to their maximum height, and sank again by easy stages to a point probably below their present level. The sequence of levels can be determined with some accuracy from the lake terraces, but not the actual dates.

In the third paper Dr. Antevs calibrates the growth-curve of the Big Trees from intrinsic evidence alone. The maxima

on his curves enable us to date the various stages in the history of the lakes with great accuracy, after which the lake changes enable us to make a final correction of the tree-growth curve. The final result is a curve of the variations of rainfall in western North America which is by far the finest "long-series" which we possess. The change from a long period of dry climate to a period of heavy rainfall appears to occur at 850 B.C., a date which fits very well with a similar change in Europe and Asia. In the fourth paper, however, Professor Huntington arbitrarily reduces the figures derived from the salt content to less than 1,300 years, to fit in with the low level of the Caspian about 650 A.D. This modification of Jones' figures is quite unnecessary and raises a whole host of difficulties. Professor Jones attributes to the cycle of changes since 1,000 B.C. a series of lacustrine deposits which obviously refer to an older cycle dating from the Ice Age, and thereby arrives at some impossible conclusions regarding the persistence of extinct animals into historic times. Dr. Antevs in the second paper places the corresponding series in the Great Basin in their correct geological position, but ignores the possibility of a more recent cycle of changes. The views of these two authors are accordingly quite incompatible, and a certain amount of confusion is likely to be created in the mind of the unwary reader. Nevertheless the publication in a single volume of papers which deal with the same subject from different aspects has much to recommend it, if only because it shows that our knowledge of the happenings is not quite so sure as any individual author would lead us to believe. We also welcome this evidence of the activity with which palaeoclimatology is being pursued in America.

C.E.P.B.

The Deterioration of Climate in Greenland

Recent excavations near Cape Farewell, described by William Hovgaard in the *Geographical Review* for October, 1925, throw light on the fate of one at least of the early Norse colonies in Greenland, and incidentally provide a definite proof of a change of climate in historic times. The colony referred to is the "Eastern settlement," just west of Cape Farewell, and the interesting finds come from the cemetery, where they have been preserved by being permanently frozen into the ground, a condition which must have persisted for at least five hundred years. When the bodies were buried, however, the soil must have thawed, at least at midsummer. The costumes and many of the coffins, even the deepest-lying, are pierced and matted by the roots of plants, which could not have happened if the ground was permanently frozen.

The remains speak very eloquently of the fate which overtook

the colonists after their abandonment by the mother country in 1410. In the constant fight with the changing climate, their physique deteriorated and their numbers diminished until, early in the sixteenth century, we have the tragic end:—" the last Norseman . . . . . lying dead and unburied by his desolate and deserted dwelling, and holding in his hand the emblem of the cultural superiority of the European, the iron knife, which had been ground and ground to the verge of possibility."

Portable Receiver for the Electric Cup Anemometer

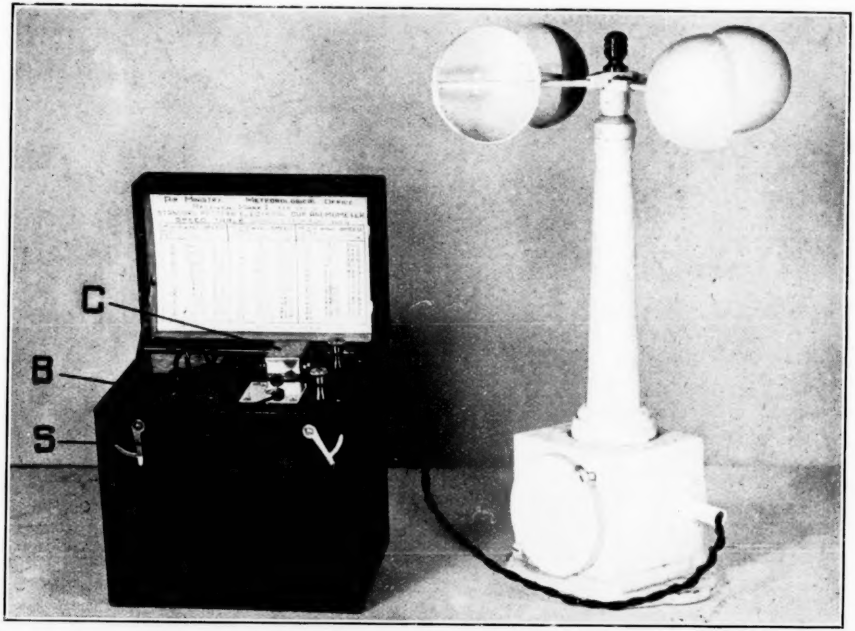
A small anemometer of the Robinson type is an inexpensive instrument for the measurement of wind velocity, in circumstances where the question of expense prohibits the installation of a more elaborate instrument, such as the Dines pressure tube anemograph. If electric contacts are provided whereby the rate of rotation of the cups may be measured through the agency of a small buzzer and battery, the instrument may be permanently erected in a well exposed situation, and connected by means of twin conductor cable to the remainder of the apparatus which may be in any convenient position. For use with anemometers of this type, a convenient form of receiver has recently been designed in the Meteorological Office, and is illustrated in our photograph. The anemometer itself, shown on the right of the picture, is provided at its base with two terminals. The receiver is also fitted with two terminals and all that is necessary, when the anemometer has been installed, is to run a length of twin cable from the instrument to the receiver and connect up the two pairs of terminals at either end. In the receiver, the connection between the batteries, marked B, and the buzzer, C, are made through a switch, S. When the switch is put to the " On " position the buzzer emits a note at regular intervals corresponding with the contacts made by the rotation of the cups. To take a measurement, all that is necessary is to measure the average interval between the buzzes, preferably with a stop watch. Tables showing the relation between this interval and the speed of the wind are supplied by the makers of the anemometers and may conveniently be pasted into the lid of the receiving apparatus.

Tapered Rain Measures

In the article on " A New Rain Measure " in the issue of the *Meteorological Magazine* for September, 1924,* it was stated that the measure can be conveniently stored when not in use by inverting it on a fixed vertical peg in a protected position, thereby

* See also *Meteorological Magazine*, 60 (1925), 265.

to face p. 14.



ELECTRIC CUP ANEMOMETER AND PORTABLE RECEIVER.

minimising the risk of breakage. In a few cases difficulty has arisen owing to the wooden peg fitting the glass measure too closely and in one instance the swelling of the peg actually broke the measure. To obviate this the diameter of the peg should be cut a little smaller than that of the measure to allow for swelling in damp weather.

Two Sunsets on One Day

THE March number of the *Marine Observer* contains a short note of an unusual refraction phenomenon observed by Mr. J. C. Kelly Rogers, in Lat. 29°S, Long. 16°E, on March 31st, 1925. He says that the unusual refraction during the afternoon caused two distinct horizons to appear, the distance between them subtending a vertical angle of from ten to fifteen minutes of arc at its greatest. The double horizon was not uniform all round the compass. The sun completely set on the upper horizon first then reappeared on the lower one and set for the second time.

The same number of the *Marine Observer* contains a sketch of a very unusual halo observed in the Caribbean Sea on March 6th, 1925.

"A Red Sky at Night......"

AN attempt has been made, since October, 1918, to classify, systematically, sunrise and sunset sky colourations in the London Area. This colour classification has consisted of resolving sunrises and sunsets into (1) reds or yellows, (2) a predominance of red over yellow, or vice versa, and (3) a combination of both colours neither one of which can be said to predominate. From this colour classification the following five types have been evolved :—

Type R (Red). All colour gradations from pink through red to crimson.

Type Y (Yellow). All colour gradations from yellow through gold to orange.

Type R+ (Red predominating). R and Y colour gradations in combination, but R predominating.

Type Y+ (Yellow predominating). Y and R colour gradations in combination, but Y predominating.

Type R+Y (Red and Yellow). R and Y gradations in combination, singly or collectively.

In order to cover the large number of cases of entirely overcast skies at sunrise and sunset a sixth type, designated X, has been used.

Both violet and green colourations have been omitted from the above classification, violet on account of its comparative rarity (in London), and green because it seldom forms an integral part

of the period of sunrise or sunset considered, occurring as a rule too early in the case of sunrise and too late in the case of sunset. Further it appeared desirable that some limit should be set to the number of types. The observations, covering a period of six years, have been grouped into Winter, October 1st to March 31st, and Summer, April 1st to September 30th. The table appended is a summary of sunrises and sunsets classified under their respective types with the percentage frequency of precipitation following the type. Entirely red sunrises and sunsets (R) occur most frequently in the winter half of the year, a red sunrise in summer being a comparatively rare phenomenon, averaging only five per summer during the period.

Type	Winter Sunrise Oct.-March, 1918-24			Winter Sunset Oct.-March, 1918-24			Summer Sunrise April-Sept., 1919-24			Summer Sunset April-Sept., 1919-24		
	No.	Precipitation followed before next		No.	Precipitation followed before next		No.	Precipitation followed before next		No.	Precipitation followed before next	
		Sunset	Sunrise		Sunrise	Sunset		Sunset	Sunrise		Sunrise	Sunset
		%	%		%	%		%	%		%	%
R	94	33	61	100	16	29	30	50	70	61	25	43
Y	103	30	40	92	42	59	274	31	38	159	23	51
R+	118	33	73	139	22	34	77	53	70	194	5	27
Y+	122	26	48	140	36	50	122	29	36	188	18	46
R+Y	110	18	39	141	21	38	120	26	33	194	10	27
X	547*	45	60	482*	51	62	475*	43	50	302*	40	55

There is a very marked predominance of yellow sunrises (Y) in the summer half of the year, this type yielding the largest individual number of any considered. It was of very frequent occurrence during the dry summer of 1921. Red predominating (R+) is comparatively infrequent at summer sunrise as is the case with all red (R). Types Y+ and R+Y show a fairly even seasonal distribution both at sunrise and sunset. Entirely overcast skies, X, occur most frequently at sunrise in winter and least so at sunset in summer, but both winter sunset and summer sunrise yield a comparatively high percentage of overcast skies. R and R+ sunrises, both in winter and summer, are followed by a high precipitation frequency, the reverse holding for sunsets, more especially in winter. Y and Y+ sunrises, especially Y in summer, are followed by a low precipitation frequency, the reverse holding for sunsets, more especially in winter. Sunrises and sunsets classified as type R+Y are followed by a relatively low precipitation frequency, both at sunrise and sunset, and in winter and summer. Entirely overcast skies, X, yield a com-

* For Type X precipitation was actually occurring at the time of observation in 135 cases (25%) at Winter Sunrise, 153 cases (32%) at Winter Sunset, 91 cases (19%) at Summer Sunrise, 99 cases (33%) at Summer Sunset, and these numbers have been deducted in arriving at the succeeding precipitation frequency.

paratively high succeeding precipitation frequency for all periods, the lowest occurring with summer sunrise, and the highest with winter sunset.

It is proposed, on a future occasion, to consider the cloud form or forms associated with the respective colour types.

SPENCER RUSSELL.

Radiation from the Sky

RADIATION MEASURED AT BENSON, OXON, 1925.

Unit: one gramme calorie per square centimetre per day.

ATMOSPHERIC RADIATION only (dark heat rays)

Averages for Readings

		Oct.	Nov.	Dec.
Cloudless days :—				
Number of readings	n	5	9	8
Radiation from sky in zenith ...	πI	519	401	373
Total radiation from sky ...	J	553	431	405
Total radiation from horizontal black surface on earth ...	X	736	633	606
Net radiation from earth ...	$X—J$	183	202	201

DIFFUSE SOLAR RADIATION (luminous rays).

Averages for Readings between 9 h. and 15 h. G.M.T.

		Oct.	Nov.	Dec.
Cloudless days :—				
Number of readings	n_0	4	4	4
Radiation from sky in zenith ...	πI_0	29	19	19
Total radiation from sky ...	J_0	32	28	24
Cloudy days :—				
Number of readings	n_1	4	3	3
Radiation from sky in zenith ...	πI_1	118	87	38
Total radiation from sky ...	J_1	105	79	31

Unit for I = gramme calorie per day per steradian per square centimetre.

Unit for J and X = gramme calorie per day per square centimetre.

For description of instrument and methods of observation, see *The Meteorological Magazine*, October, 1920, and May, 1921.

Upper Air Work in the Argentine

THE report of the Meteorological Office of the Argentine Republic for 1924, has just been issued, and from it we learn that great efforts have been made during 1924 to obtain the necessary

funds and materials for the re-organization of the aerological work which was initiated 15 years ago, but which has not been able to be maintained. In the meanwhile, by the help of voluntary contributions, work has been started at the Villa Ortúzar, Buenos Aires. Forty-three pilot balloon ascents were made between December 8th and 31st, usually one at 7h. 30 m., and one at 13 h. 30 m. On the 27th the balloon sent up at 13 h. 30 m. was observed to a height of 10,350 m. (33,950 ft.), the readings being then suspended on account of the rain.

Isle of Wight Weather

Mr. J. E. Cowper informs us that at Shanklin, Isle of Wight, the rainfall of 43·71 in. measured in 1925 only just failed to equal the largest total on record (43·82 in. in 1912) in spite of the record drought of June (only a "trace") and the total of 0·28 in. in March, the smallest known in that month. At Newport the annual fall was 48·40 in., at Sandown only 34·56 in.

On the morning of January 7th, 1926, a severe rain and hailstorm was experienced in the Island, accompanied by a dense black cloud, heavy wind and in some places thunder. At Niton, near Ventnor, the disturbance was seen to sweep in from the sea about 10h. 30m. and apparently had some of the characteristics of a tornado. Hay, straw and light articles were whirled aloft to great heights. The only notable damage was on the top of the hill where the brick gable end of a large cow-shed gave way under the wind pressure and a large portion of corrugated iron roofing was torn away from the rafters, some of the sheets of iron being blown 100 ft. away. At Shanklin the hailstones were remarkably large.

Frequency of Rainy Days in London

Mr. C. A. Bracey has made an analysis of the daily amounts of rainfall at Brixton for the 40 years 1871 to 1910. From 1871 to 1905 the record was maintained at Acre Lane by the late Mr. F. Gaster, and subsequently by Mr. Bracey at St. James's Road. The day covers the 24 hours beginning 9 a.m. on the day of entry, and days with no rain or only traces (less than 0.005 in.) are counted as dry. The 40 daily values were tabulated for each calendar day throughout the year, and the means extracted. In addition, the number of days on which January 1st was rainless were counted, and so on for each day of the year. The annual average was 24·32 in. on 166 days, so that the mean fall per day was 0·067 in. and the mean fall per day of rain 0·147 in. For the whole period the percentage of dry days was 55, but for each of the seven months, March to September, the percentage

was nearly 60, and for each of the remaining five months, October to February, it was only 50. It is of interest to be reminded at this time of the year that in London the chances are even of a day with measurable rain or with negligible rain of less than 0·005 in., while in the summer months dry days are more frequent than rainy days. Statistics similar to the above can be computed for various stations in the British Isles from data given in the *Book of Normals of Meteorological Elements for the British Isles*, Section I. As would be expected, stations with more rain than London have more rain-days, but, apart from this, there is a fairly regular increase in the number of rain-days from the south-east of the British Isles to the north-west. At Nairn, which is situated on the Moray Firth, and is to the north-north-west of London, the average annual rainfall is about the same as London (24·94 in.), but only 42 per cent. of the days throughout the year are dry, and in no months are more than half the days dry. Mr. Bracey also gives statistics of the frequency of occurrence of dry days on any particular date. The values throughout the year are fairly uniform. The extremes are of interest: September 14th was dry on 32 occasions out of the 40, and December 6th on only 8 occasions. It is remarkable that from September 9th to 20th as many as 65 per cent. of the days were dry. For the 10 days preceding Christmas, dry days predominated, forming as many as 61 per cent., and of the 40 Christmas days, 21 were dry. Although with a longer period the values would tend to be equalised, the seasonal variation with fewer days of rain in the summer months is well marked. The working sheets are available for reference in the Meteorological Office, and it would be interesting to be able to refer to similar results for a number of stations situated in various parts of the British Isles.

J.G.

Reviews

The Influence of Rainfall on the Yield of Wheat at Rothamsted. By R. A. Fisher (London, Phil. Trans. R. Soc. B. 213 (1924), pp. 89-142.)

This paper deals mainly with a comparison of rain statistics with wheat data derived from the Broadbalk field at Rothamsted. At Broadbalk thirteen plots have been continuously under uniform treatment since 1852. An account of the variations in yield of grain of these plots has already been published.* It was found that the variations could be divided into groups ascribable to three separate causes: (1) on many of the plots

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* *An examination of the Dressed Grain from Broadbalk*, by R. A. Fisher, J. Agric. Sci. 11, 1921, pp. 107-135.

a progressive diminution is observable owing to the exhaustion of certain of the essential plant nutrients in the soil; (2) on all the plots slow changes in yield have taken place, which may be ascribed to variations in the weed infestation of the field as a whole; this variation, unlike that ascribable to the other two causes, is in all the plots approximately proportional to the mean yield; and (3) a variation ascribed primarily to variations of the whole sequence of weather influencing the crop from its inception to the time the product is weighed. The present paper considers the third variation, viz.: the fluctuations in yield from year to year in relation to the rainfall record.

The readings of rainfall are taken from a large gauge 0·001 acre in area, which was built for the purpose in 1853. The author disposes of the readings from other rain gauges in two sentences —the " readings of this large gauge have been consistently higher than those of the 5-inch and 8-inch gauges which are at present placed beside it. It may be concluded that the large gauge gives a better estimate of the amount of rain falling in the field." The relationship between these three gauges is not quite so simple, and it would have been more satisfactory had the author discussed in greater detail the variations of the three gauges.

The number of subdivisions into which the rainfall of each year should be divided is discussed. If the number is too small, different crop stages will be confused, while if the number is too large, the statistical treatment will present difficulties. To obviate the irregularity of the calendar the year was taken to be of 366 days, commencing on either August 31st or September 1st prior to the sowing of the seed. This 366 day year was subdivided into 61 equal periods of six days.

It is pointed out that the information provided by a comparison of the rain record with the subsequent yields tell us the effect, not so much of rain, as such, as of the combination of meteorological phenomena associated with rain. Thus, rain is associated with temperatures below normal in summer and above normal in winter, and generally with diminished sunshine. The effects of these " form an integral part of the value of a rain record as a means of foreseeing the prospects of the crop." In addition rain supplies fully aerated water while it doubtless hinders root development by soil saturation.

Curves showing the average effect on the yield for each additional inch of rain, throughout the year, have been constructed for the 13 plots of wheat. In all the plots the effect of rainfall above the normal is in general harmful. In October the average loss per inch of rain is small, and a rainfall above the average may even be beneficial. In 11 out of the 13 plots the autumn period of benefit, or but little loss from heavy rain is followed by a period centred in January in which dry conditions appear

to be particularly desirable. At this time of the year each additional inch of rain costs from one to two bushels in the crop, but this effect is shown least on the unmanured plot, which confirms the conclusion arrived at from the statistical analysis, that the damage done by winter rains is principally occasioned by the washing out of soluble nitrates from the soil.

In the paper an attempt is made to develop formulæ which shall predict the yield from the weather statistics, and in the last section a summary is given of previous investigations bearing on the present data. J.G.

Cloud Studies. By A. W. Clayden. (Second Edition.) $8 \times 5\frac{3}{4}$, pp. xvi.+200. *Illus.* London, John Murray, 1925. 15s. net.

Although the study of clouds is becoming more and more important as a feature of meteorological routine, the number of works dealing specifically with the subject is still surprisingly small. In recent years there have been two substantial additions to the literature—G. A. Clarke's *Clouds*, and Schereschewsky and Wehrle's *Les Systèmes Nuageux.* Nevertheless, our libraries are far from being overburdened with books on the clouds, and the appearance of a new edition of A. W. Clayden's well-known work is very welcome.

Twenty years, full of incident in the development of meteorology, have passed since the publication of the first edition, and it is not surprising, therefore, that the author has found it necessary to make some additions and alterations to the text. With the exception of a few worthy additions, however, the illustrations are unaltered. In these days of ready-made panchromatic plates, the photography of clouds is shorn of its terrors and it is no longer necessary to invoke the aid of a black mirror in order to bring cirrus clouds within range. When Clayden began his work nobody had given much attention to the problem and he had to devise means of obtaining results with a medium which was fundamentally unsuited to the purpose. The success which he achieved was very remarkable and it is unnecessary to be either a meteorologist or a photographer to appreciate the beauty and fidelity of his pictures.

In common with many of those who have devoted their talents to the study of clouds, Clayden is not satisfied with the classification adopted for the *International Cloud Atlas.* He thinks we should go further and give specific names to all the different varieties of the same type of cloud which are seen to present themselves. We are thus brought face to face with such names as "Alto-cumulus castellatus fractus." He figures no fewer than nine varieties of cirrus, four of cirro-stratus and three of cirro-cumulus, while subdivisions in the middle and lower

groups are almost as numerous. There is no doubt that such a term as cirrus includes, in practice, a considerable variety of more or less distinct forms, and it is a matter for consideration as to whether the time has not now arrived to reconsider the whole question of cloud nomenclature. It seems unlikely, however, that any large measure of support would be forthcoming for so extensive a scheme as that adopted in the book now before us. E.G.B.

E. T. Busk. A pioneer in flight. By Mary Busk. Size $8 \times 5\frac{3}{4}$, pp. x.+167, London, John Murray, 1925, 7s. 6d.

The book comprises a biography of E. T. Busk and a short memoir of his younger brother H. A. Busk, written by their mother. E. T. Busk showed an aptitude for mechanical construction and an interest in aeronautics at an early age: at Cambridge he proved his mathematical ability. A few years after leaving the University the problem of aeroplane stability interested him and, at his home in Sussex, he fitted up a workshop in which he made his own experimental outfit. His work at this time included research into the nature and causes of wind gusts; he constructed several instruments for recording wind velocities, one of which is now at the National Physical Laboratory, Teddington. The results of these investigations are not given in the biography.

In the summer of 1912, Busk was appointed head of the "Physics" Department at the Royal Aircraft Factory, Farnborough, and here he continued his investigations into aeroplane stability, doing a considerable amount of experimental flying. He was one of the first aviators to apply scientific methods to the investigation of the behaviour of an aeroplane in flight, being mainly responsible for the design of an inherently stable aeroplane of a type used extensively by British Forces in the field during the early part of the war. The gold medal of the Aeronautical Society of Great Britain was awarded to him in 1914 for his services to aeronautics. Busk lost his life in November, 1914, when the aeroplane in which he was flying caught fire in the air: the country lost an able research worker in aeronautics at a time when his services would have been of the greatest value.

H. A. Busk was a pilot in the Royal Naval Air Service and served in the Eastern Mediterranean in 1915 and 1916, meeting his death while returning from a bombing expedition.

M.T.S.

Erratum

Vol. 60, January, 1926, p. 292, the percentage values of the rainfall for 1925 should read, England and Wales, 108, Scotland, 101, Ireland, 98, and the British Isles, 104.

News in Brief

An exceptional fine display of the Aurora Borealis was witnessed in many parts of Norway on the night of January 26th to 27th. The sky visible from southern Norway was ablaze with rose-coloured light while from the north the predominant colour was white. The reflection was observed in Sweden and Denmark.

Mr. A. D. Pilkington, of Newbury, Berks., reports that his thermometer registered 4° below zero, *i.e.*, 36° of frost at 2 feet from the ground about 11 p.m. on the night of the 16th.

Mr. J. J. Somerville, B.A., B.L., Meteorologist-in-Charge at Renfrew Aerodrome, was called to the Bar, by the Honourable Society of Gray's Inn, on January 26th, 1926.

The Seventh Annual Soirée of the Meteorological Office Staff was held on Friday, February 12th, at Australia House. Some 240 past and present members of the Staff and their friends enjoyed a programme of music, conjuring and dancing, with a comedy sketch provided by the staff at South Kensington. Members were present from many out-stations.

The fifth Annual Dinner of the Meteorological Office Staff, at Shoeburyness, was held at the Queen's Hotel, Westcliff, on Saturday, January 30th, 1926. Mr. D. Brunt was to have been the guest upon this occasion, but was unavoidably prevented at the last moment from being present. Past members of the staff now stationed elsewhere were present and a very enjoyable time was spent. A musical programme consisting of original items was rendered by members of the staff.

Books Received.

THE PYCNOSONDE. An apparatus for hydrographic soundings. By D. la Cour, pp. 13 (Det Danske Meteorologiske Institut Yearbooks, Copenhagen), 1926.

The Weather of January, 1926

The mild unsettled weather which prevailed at the close of December continued during the first part of January. The mean temperature for the first week of the year was everywhere considerably above normal, the greatest excess being 5·8° F. in the Midlands. Rain and high winds occurred almost daily during the first ten days, the heaviest rain being reported on the 1st, when 85 mm. (3·33 in.) occurred at Tynywaun (Glamorgan), and on the 8th when 61 mm. (2·40 in.) occurred at Achna-

shellach. The floods which were so widespread over the country at the beginning of the month began to subside gradually about the 8th. After the 11th the high pressure area over Europe became connected, by a narrow ridge across the British Isles to the Azores anticyclone, and pressure fell over southwest Europe bringing a definite change to our weather. Thick fog occurred in many places early on the 12th, and the easterly winds were associated with a decided fall in the temperature. The following day a depression near Spain caused a gale in the English Channel and snow fell during the night. Further falls became general for some few days as the low pressure system shifted northwards. Owing to the persistence of frosty weather much of the snow lay on the ground for many days and by the 16th was about a foot deep at South Farnborough. Temperature remained below the freezing point for some days in succession. At Leafield and Cranwell the maximum was as low as 22° F. on the 16th, while screen minimum readings fell to 7° F. at Cambridge on the 16th and to 4° F. at Rothamsted on the 17th, and ground minima to 0° F. at Oxford and —2° F. at Cranwell on the 17th. At Hampstead the grass minimum temperature of 6° F. recorded there on the 16th was the lowest since March, 1909. On the 17th depressions approaching from the Atlantic brought milder weather to the western districts, though in the eastern districts cold weather persisted with snow and fog at times. By the 23rd, however, strong warm southwest winds had extended to the North Sea and mild unsettled weather predominated during the last week with further high winds and heavy rain at times but many bright intervals. The total rainfall of the month was more than twice the normal at isolated stations in south and east England, east Scotland and southeast Ireland, but below the normal in parts of northeast Scotland. In Ireland the month was the wettest January since 1877; the general fall was 184 per cent. of the average, compared with 198 per cent. in 1877.

Pressure was below normal over the British Isles, Iceland and the northern part of the North Atlantic Ocean but above normal in both southwestern and northern Europe. This distribution favoured southerly winds over the British Isles. Except in Sweden and the extreme north of Norway, the temperature and rainfall were above normal generally in western Europe. At Spitsbergen the temperature excess was as much as 6° F. and at Valencia (Ireland) the rainfall excess 126 mm. Heavy rains fell over most of Europe during the beginning of the month, and these combined with the thaw which occurred in the latter part of December caused serious floods in many parts of the continent. The suffering and damage done in the parts of the countries under water were very great. Many of the dykes burst in Holland and a serious landslide occurred near Lucerne. The floods

began to abate slowly on the 4th and 5th though the Seine continued to rise until about the 9th. On the 11th the intensely cold weather which had been prevalent in the north of Russia spread also across Europe and the flood waters froze, causing still greater distress in the west where the ice was not strong enough to bear vehicles. Many ships were icebound in the Baltic and snow storms occurred as far south as the Riviera, Naples, and the province of Valencia. Gales were reported from Barcelona and the Bay of Biscay on the 12th and 13th, and from Las Palmas between the 16th and 19th. During the last ten days there was a return to warmer conditions generally.

In Africa, early in the month, the prolonged drought caused great anxiety in the Transvaal and the Orange Free State, and intense heat was experienced in Pretoria. Towards the middle of the month torrential rains fell in southern Rhodesia and Portuguese East Africa, and floods occurred on the Pungwe River.

Heavy rain, which is most unusual at this time of the year, flooded parts of Bombay on the 2nd and 3rd. A hurricane was reported from Samoa and Society Island on the 1st causing several deaths and much damage. The rainfall in Australia was generally below normal, except in Kimberley where it was about twice the normal. In parts of the north and central coasts of Queensland it was less than half the normal. Several bushfires have followed the intense summer heat in Victoria.

Floods occurred early in the month in Mexico.

From the 24th to the end of the month severe storms were experienced over the Atlantic when both the "Antinoe" and the "Laristan" were lost after the gallant rescues by the "President Roosevelt" and the "Bremen." Sir Napier Shaw, in an article in the *Times* on Winter Storms over the Atlantic, points out the similarity which the meteorological situation on January 31st, 1926, bore to that on February 6th, 1899, about which time many casualties occurred on the Atlantic.

The special message from Brazil states that the rainfall distribution was irregular in the northern and central districts, where the totals were 39 mm. below normal and 32 mm. above normal respectively. In the southern districts the rainfall was abundant, being 74 mm. above normal. The cotton and cane crops are suffering from lack of rain in the north, and the vegetables, through excessive rain in the south. At Rio de Janeiro pressure was 0·7 mb. below normal and the temperature normal.

Rainfall, January, 1926—General Distribution

England and Wales ..	152	per cent. of the average 1881-1915.
Scotland	141	
Ireland	184	
British Isles	156	

Rainfall: January, 1926: England and Wales

CO.	STATION.	In.	mm.	Per-cent. of Av.	CO.	STATION.	In.	mm.	Per cent of Av.
Lond.	Camden Square	2·64	67	142	*War.*	Birminghm, Edgbaston	3·11	79	154
Sur.	Reigate, Hartswood	3·38	86	150	*Leics*	Thornton Reservoir	2·88	73	145
Kent.	Tenterden, Ashenden	3·02	77	140	,,	Belvoir Castle	2·57	65	145
,,	Folkestone, Boro. San.	2·65	67	...	*Rut.*	Ridlington	3·22	82	...
,,	Margate, Cliftonville	1·43	36	86	*Linc.*	Boston, Skirbeck	2·79	71	172
,,	Sevenoaks, Speldhurst	3·60	91	...	,,	Lincoln, Sessions House	2·33	59	139
Sus.	Patching Farm	4·46	113	171	,,	Skegness, Estate Office.	2·64	67	153
,,	Brighton, Old Steyne	3·47	88	143	,,	Louth, Westgate	2·92	74	135
,,	Tottingworth Park	4·95	126	183	,,	Brigg	3·24	82	181
Hants	Ventnor.Roy.Nat.Hos.	3·99	101	155	*Notts.*	Worksop, Hodsock	2·22	56	125
,,	Fordingbridge, Oaklnds	5·37	136	194	*Derby*	Mickleover, Clyde Ho.	2·82	72	141
,,	Ovington Rectory	7·18	182	266	,,	Buxton, Devon. Hos.	5·19	132	116
,,	Sherborne St.JohnRec.	3·89	99	167	*Ches.*	Runcorn, Weston Pt.	2·58	65	109
Berks	Wellington College	3·17	81	160	,,	Nantwich, Dorfold Hall	2·53	64	...
,,	Newbury, Greenham	4·89	124	211	*Lancs*	Manchester, Whit. Pk.	2·90	74	116
Herts.	Benington House	2·77	70	152	,,	Stonyhurst College	4·75	121	111
Bucks	High Wycombe	3·71	94	178	,,	Southport, Hesketh	3·29	84	129
Oxf.	Oxford, Mag. College	3·67	93	214	,,	Lancaster, Strathspey.	4·37	111	...
Nor.	Pitsford, Sedgebrook	2·91	74	156	*Yorks*	Sedbergh, Akay	8·82	224	160
,,	Eye, Northolm	2·63	67	...	,,	Wath-upon-Dearne	2·23	57	116
Beds.	Woburn, Crawley Mill.	...	...	...	,,	Bradford, Lister Pk.	3·90	99	135
Cam.	Cambridge, Bot. Gdns.	1·86	47	124	,,	Wetherby, Ribston H.	3·17	81	154
Essex	Chelmsford, CountyLab	2·21	56	146	,,	Hull, Pearson Park	3·21	81	178
,,	Lexden, Hill House	2·41	61	...	,,	Holme-on-Spalding	2·52	64	...
Suff.	Hawkedon Rectory	2·23	57	128	,,	West Witton, Ivy Ho.	4·43	113	...
,,	Haughley House	1·86	47	...	,,	Felixkirk, Mt. St. John	2·16	55	108
Norf.	Beccles, Geldeston	2·09	53	126	,,	Pickering, Hungate	2·66	68	...
,,	Norwich, Eaton	2·78	71	142	,,	Scarborough	2·29	58	115
,,	Blakeney	3·59	91	208	,,	Middlesbrough	1·69	43	106
,,	Swaffham	3·21	81	177	,,	Baldersdale, Hury Res.	3·76	95	106
Wilts.	Devizes, Highclere	3·36	85	154	*Durh.*	Ushaw College	2·97	75	145
,,	Bishops Cannings	3·20	81	138	*Nor.*	Newcastle, Town Moor.	2·45	62	120
Dor.	Evershot, Melbury Ho.	4·94	125	142	,,	Bellingham, Highgreen	3·57	91	...
,,	Creech Grange	5·87	149	...	,,	Lilburn Tower Gdns.	3·51	89	...
,,	Shaftesbury, Abbey Ho.	4·51	115	173	*Cumb*	Geltsdale	3·65	93	...
Devon	Plymouth, The Hoe	5·79	147	174	,,	Carlisle, Scaleby Hall	2·77	70	112
,,	Polapit Tamar	6·97	177	187	,,	Seathwaite M.	20·10	511	152
,,	Ashburton, Druid Ho.	9·62	244	189	*Glam.*	Cardiff, Ely P. Stn.	6·74	171	178
,,	Cullompton	6·16	157	190	,,	Treherbert, Tynywaun	16·16	411	...
,,	Sidmouth, Sidmount	3·83	97	134	*Carm*	Carmarthen Friary	7·38	187	168
,,	Filleigh, Castle Hill	6·98	177	...	,,	Llanwrda, Dolaucothy.	8·03	204	151
,,	Barnstaple,N.Dev.Ath.	5·55	141	170	*Pemb*	Haverfordwest, School	7·97	202	173
Corn.	Redruth, Trewirgie	7·16	181	170	*Card.*	Gogerddan	4·63	118	113
,,	Penzance, Morrab Gdn.	5·57	141	147	,,	Cardigan,County Sch.	4·91	125	...
,,	St. Austell, Trevarna	7·62	193	178	*Brec.*	Crickhowell, Talymaes	7·10	180	...
Soms	Chewton Mendip	6·40	163	167	*Rad.*	Birm.W.W.Tyrmynydd	9·51	242	151
,,	Street, Hind Hayes	3·46	88	...	*Mont.*	Lake Vyrnwy	8·77	223	155
Glos.	Clifton College	5·36	136	189	*Denb.*	Llangynhafal	2·91	74	...
,,	Cirencester, Gwynfa	5·14	131	199	*Mer.*	Dolgelly, Bryntirion	6·39	162	112
Here.	Ross, Birchlea	4·05	103	167	*Carn.*	Llandudno	2·65	67	103
,,	Ledbury, Underdown.	3·40	86	155	,,	Snowdon, L. Llydaw 9	20·30	516	...
Salop	Church Stretton	3·95	100	156	*Ang.*	Holyhead, Salt Island.	3·21	82	110
,,	Shifnal, Hatton Grange	2·49	63	128	,,	Lligwy	3·50	89	...
Staff.	Tean, The Heath Ho.	3·26	83	127	*Isle of Man*				
Worc.	Ombersley, Holt Lock.	2·93	74	153		Douglas, Boro' Cem.	5·35	136	160
,,	Blockley, Upton Wold.	3·24	82	138	*Guernsey*				
War.	Farnborough	3·57	91	166		St. Peter P't, Grange Rd	5·70	145	195

Rainfall: January, 1926: Scotland and Ireland

CO.	STATION	In.	mm.	Per-cent. of Av.	CO.	STATION.	In.	mm.	Per-cent of Av.
Wigt.	Stoneykirk, Ardwell Ho	4·50	114	152	*Suth.*	Loch More, Achfary	6·95	177	95
,,	Pt. William, Monreith	5·60	142	...	*Caith*	Wick	2·22	56	90
Kirk.	Carsphairn, Shiel.	14·15	359	...	*Ork*	Pomona, Deerness	3·20	81	93
,,	Dumfries, Cargen	7·19	183	180	*Shet.*	Lerwick	5·22	133	123
Roxb	Branxholme	4·37	111	159					
Selk.	Ettrick Manse	9·84	250	140	*Cork*	Caheragh Rectory	10·21	259	...
Berk.	Marchmont House	3·16	80	151	,,	Dunmanway Rectory	11·17	284	187
Hadd	North Berwick Res.	2·61	66	152	,,	Ballinacurra	7·59	193	191
Midl	Edinburgh, Roy. Obs.	2·67	68	150	,,	Glanmire, Lota Lo.	9·36	238	218
Lan.	Biggar	4·06	102	...	*Kerry*	Valencia Obsy.	10.48	266	191
,,	Leadhills	13·63	346	...	,,	Gearahameen	18·50	470	...
Ayr	Kilmarnock, Agric. C.	4·28	109	123	,,	Killarney Asylum	9·45	240	160
,,	Girvan, Pinmore	7·93	201	168	,,	Darrynane Abbey	9·29	236	185
Renf.	Glasgow, Queen's Pk.	4·64	118	139	*Wat.*	Waterford, Brook Lo.	8·41	214	228
,,	Greenock, Prospect H.	10·73	273	157	*Tip.*	Nenagh, Cas. Lough	7·34	186	185
Bute	Rothesay, Ardencraig.	7·40	188	165	,,	Tipperary	8·52	216	...
,,	Dougarie Lodge	7·53	191	...	,,	Cashel, Ballinamona	7·31	186	192
Arg.	Ardgour House	14·15	359	...	*Lim.*	Foynes, Coolnanes	5·32	135	141
,,	Manse of Glenorchy	13·69	348	...	,,	Castleconnell Rec.	5·11	130	...
,,	Oban	7·72	196	...	*Clare*	Inagh, Mount Callan	8·40	213	...
,,	Poltalloch	7·70	196	152	,,	Broadford, Hurdlest'n.	6·75	171	...
,,	Inveraray Castle	12·44	316	149	*Wexf*	Newtownbarry	10·32	262	...
,,	Islay, Eallabus	8·41	214	175	,,	Gorey, Courtown Ho.	8·24	209	264
,,	Mull, Benmore	14·80	376	...	*Kilk.*	Kilkenny Castle	7·42	188	232
Kinr.	Loch Leven Sluice	5·11	130	162	*Wic.*	Rathnew, Clonmannon	7·92	201	...
Perth	Loch Dhu	16·20	411	178	*Carl.*	Hacketstown Rectory	7·91	201	223
,,	Balquhidder, Stronvar.	13·98	355	165	*QCo.*	Blandsfort House	7·13	181	217
,,	Crieff, Strathearn Hyd.	7·71	196	191	,,	Mountmellick	7·69	195	...
,,	Blair Castle Gardens	6·48	165	195	*KCo.*	Birr Castle	4·55	115	161
,,	Coupar Angus School	4·81	122	203	*Dubl.*	Dublin, FitzWm. Sq.	4·30	109	188
Forf.	Dundee, E. Necropolis	4·78	121	245	,,	Balbriggan, Ardgillan	3·93	100	172
,,	Pearsie House	7·36	187	...	*Me'th*	Drogheda, Mornington	3·69	94	...
,,	Montrose, Sunnyside	3·91	99	200	,,	Kells, Headfort	5·66	144	180
Aber.	Braemar, Bank	5·12	130	160	*W.M*	Mullingar, Belvedere	6·21	158	193
,,	Logie Coldstone Sch.	2·36	60	107	*Long*	Castle Forbes Gdns.	6·25	159	188
,,	Aberdeen, King's Coll.	3·24	82	149	*Gal.*	Ballynahinch Castle	10·18	259	164
,,	Fyvie Castle	2·70	69	...	,,	Galway, Grammar Sch.	4·94	125	...
Mor.	Gordon Castle	1·76	45	87	*Mayo*	Mallaranny	9·61	244	...
,,	Grantown-on-Spey	1·64	42	68	,,	Westport House	7·38	187	159
Na.	Nairn, Delnies	1·74	44	87	,,	Delphi Lodge	16·50	419	...
Inv.	Ben Alder Lodge	8·48	215	...	*Sligo*	Markree Obsy.	6·05	154	154
,,	Kingussie, The Birches	3·10	79	...	*Cav'n*	Belturbet, Cloverhill	5·19	132	174
,,	Loch Quoich, Loan	19·00	483	...	*Ferm*	Enniskillen, Portora	6·32	161	...
,,	Glenquoich	...	...	...	*Arm.*	Armagh Obsy.	4·90	124	195
,,	Inverness, Culduthel R.	1·91	49	...	*Down*	Warrenpoint	6·19	157	...
,,	Arisaig, Faire-na-Squir	5·82	148	...	,,	Seaforde	7·63	194	242
,,	Fort William	12·25	311	127	,,	Donaghadee, C. Stn.	3·87	98	152
,,	Skye, Dunvegan	11·04	280	...	,,	Banbridge, Milltown	3·87	98	173
,,	Barra, Castlebay	4·26	108	...	*Antr.*	Belfast, Cavehill Rd.	4·91	125	...
R&C	Alness, Ardross Cas.	3·18	81	84	,,	Glenarm Castle	6·84	174	...
,,	Ullapool	4·26	108	...	,,	Ballymena, Harryville	4·98	127	134
,,	Torridon, Bendamph	13·39	340	143	*Lon.*	Londonderry, Creggan	5·64	143	157
,,	Achnashellach	12·41	315	...	*Tyr.*	Donaghmore	6·89	175	...
,,	Stornoway	5·47	139	106	,,	Omagh, Edenfel	6·49	165	183
Suth.	Lairg	2·92	74	...	*Don.*	Malin Head	4·98	127	191
,,	Tongue Manse	2·67	68	68	,,	Dunfanaghy	6·23	158	154
,,	Melvich School	1·78	45	54	,,	Killybegs, Rockmount	7·07	180	126

Climatological Table for the British Empire, August, 1925

STATIONS	PRESSURE: Mean of Day M.S.L.	PRESSURE: Diff. from Normal	TEMPERATURE: Absolute Max.	TEMPERATURE: Absolute Min.	TEMPERATURE: Mean Values Max.	TEMPERATURE: Mean Values Min.	TEMPERATURE: Mean Values ½ max. and min.	TEMPERATURE: Mean Values Diff. from Normal	TEMPERATURE: Mean Wet Bulb.	Relative Humidity	Mean Cloud Am'nt	PRECIPITATION: Am'nt	PRECIPITATION: Diff. from Normal	PRECIPITATION: Days	BRIGHT SUNSHINE: Hours per day	BRIGHT SUNSHINE: Percentage of possible.
	mb.	mb.	° F.	° F.	° F.	° F.	° F.	° F.	° F.	%	0—10	mm.	mm.			
London, Kew Obsy.	1015·4	+ 0·1	77	47	68·5	54·0	61·3	− 0·3	56·2	87	7·6	65	+ 8	15	4·6	32
Gibraltar	1016·5	− 0·2	89	64	82·5	68·5	75·5	− 0·5	66·4	76	6·8	1	− 2	2	...	...
Malta	1014·9	− 0·4	102	70	85·8	74·4	80·1	+ 1·0	74·6	77	1·2	0	− 3	0	11·1	82
Sierra Leone	1014·3	+ 1·0	85	71	81·9	72·5	77·2	− 1·0	73·7	85	7·9	873	− 29	23	...	...
Lagos, Nigeria	1011·7	− 1·9	86	72	83·1	73·7	78·4	+ 1·3	74·2	80	8·5	33	− 35	10	...	...
Kaduna, Nigeria	1014·4	+ 0·6	88	63	81·8	66·1	73·9	0·0	69·7	89	2·2	423	+177	24	...	...
Zomba, Nyasaland	1018·1	+ 1·4	80	47	76·2	53·8	65·0	+ 0·3	...	77	4·8	3	− 6	1	...	...
Salisbury, Rhodesia	1019·0	+ 0·2	82	34	74·9	43·9	59·4	− 0·5	50·4	51	0·5	0	− 2	0	10·4	90
Cape Town	1020·3	+ 0·6	77	42	63·8	49·7	56·7	+ 1·1	51·6	89	5·3	40	− 43	9	...	...
Johannesburg	1022·6	+ 1·7	78	35	69·0	45·8	57·4	+ 3·5	44·3	54	0·5	2	− 7	1	10·2	92
Mauritius	1021·4	+ 0·9	77	54	74·5	61·3	67·9	− 0·6	63·3	69	6·2	60	0	16	7·3	64
Bloemfontein	...	...	79	26	71·0	34·7	52·9	+ 0·7	42·7	63	0·9	6	− 6	1	...	...
Calcutta, Alipore Obsy.	1000·3	− 0·7	93	78	89·9	80·0	84·9	+ 1·9	79·9	89	8·8	204	−118	11*	...	...
Bombay	1005·1	− 0·8	87	76	85·4	78·1	81·7	+ 1·0	76·6	83	8·1	196	−171	15*	...	...
Madras	1004·7	− 0·8	98	73	93·7	77·1	85·4	− 0·5	76·2	74	6·9	152	+ 34	9*	...	...
Colombo, Ceylon	1009·2	− 0·5	87	73	85·0	76·9	80·9	− 0·2	77·2	76	8·8	122	+ 45	12	6·3	51
Hong Kong	1003·8	− 1·3	93	76	87·4	78·9	83·1	+ 1·0	77·9	74	7·1	143	−214	11	7·3	57
Sandakan	...	...	91	72	87·4	76·0	81·7	− 0·2	76·1	81	...	145	− 60	6	...	...
Sydney	1021·0	+ 2·8	75	40	61·3	46·4	53·9	− 1·1	49·6	72	5·5	123	+ 47	13	5·8	53
Melbourne	1021·7	+ 3·6	68	31	57·4	41·2	49·3	− 1·8	44·9	78	6·5	35	− 11	16	5·5	51
Adelaide	1022·7	+ 3·5	75	36	60·8	44·1	52·5	− 1·4	47·2	71	6·2	42	− 22	14	5·4	50
Perth, W. Australia	1023·0	+ 4·2	72	38	64·1	45·6	54·9	− 1·9	49·4	65	3·6	48	− 96	9	8·0	73
Coolgardie	1023·4	+ 4·1	72	32	63·7	39·6	51·7	− 1·9	43·9	58	2·9	2	− 24	4	...	...
Brisbane	1020·3	+ 1·1	78	43	69·5	51·2	60·3	− 0·1	53·5	69	3·5	80	+ 26	9	7·5	67
Hobart, Tasmania	1017·5	+ 3·9	65	33	53·8	38·9	46·3	− 1·7	41·2	74	5·5	41	− 6	16	6·2	60
Wellington, N.Z.	1014·7	0·0	63	30	54·0	42·7	48·3	− 0·3	45·3	82	7·7	208	+ 94	21	3·3	31
Suva, Fiji	1013·0	− 1·3	87	62	77·7	66·9	72·3	− 1·4	68·1	79	6·3	129	− 80	11	...	...
Apia, Samoa	1011·4	− 0·8	90	70	85·1	74·1	79·6	+ 1·8	75·6	75	4·4	19	− 61	6	8·3	71
Kingston, Jamaica	1013·5	0·0	93	69	90·6	73·0	81·8	+ 0·3	72·1	83	3·8	43	− 50	7	...	...
Grenada, W.I.	1013·8	+ 1·2	89	70	84·5	74·5	79·5	0·0	76·3	82	6·6	269	+ 30	27	...	...
Toronto	1018·0	+ 2·6	88	48	79·2	58·3	68·7	+ 2·1	62·2	76	3·5	63	− 7	7	9·6	69
Winnipeg	1013·4	− 0·5	91	44	78·8	56·2	67·5	+ 4·5	58·0	88	3·9	76	+ 16	15	7·9	54
St. John, N.B.	1015·3	− 0·1	83	47	70·0	54·2	62·1	+ 1·5	58·2	81	6·0	69	− 29	11	6·3	45
Victoria, B.C.	1016·5	− 0·7	82	47	68·4	53·0	60·7	+ 0·6	56·0	75	4·0	9	− 8	5	9·5	66

*For Indian stations a rain day is a day on which 0·1 in. (2·5 mm.) or more rain has fallen.

Erratum Vol. 60, January, 1926, p. 300. Mauritius July, 1925, *for* "Wet Bulb 71·1" *read* "Wet Bulb 66·0."

Victoria, B.C.	1016·5	− 0·7	82	47	68·4	53·0	60·7	+ 0·6	56·0	75	4·0	9	− 8	5	9·5	66

*For Indian stations a rain day is a day on which 0·1 in. (2·5 mm.) or more rain has fallen.
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